

Health Consultation

Graham Road Recycling and Disposal Facility Spokane County, Washington

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**Prepared by
The Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry**



FOREWORD

The Washington State Department of Health (DOH) has prepared this health consultation under cooperative agreement with the Agency for Toxic Substances Disease Registry (ATSDR), an agency of the U.S. Public Health Service. The goal of the DOH and ATSDR is to identify and mitigate adverse human health effects resulting from exposure to hazardous substances in the environment. This report was prepared in accordance with methodologies and guidelines developed by ATSDR.

A health consultation provides advice on specific public health issues that may arise as a result of an actual or potential human exposure to a hazardous substance. Health consultations provide a means for DOH to respond quickly to a request for health information on hazardous substances and to make recommendations for actions to protect public health. DOH evaluates available information about hazardous substances at a site, determines whether exposures have occurred or could occur, and reports the potential harmful effects from exposure.

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BACKGROUND AND STATEMENT OF ISSUES

The Washington State Department of Health (DOH) has prepared this health consultation at the request of the West Plains Neighborhood Association and the Washington State Department of Ecology (Ecology). The neighborhood association expressed concerns regarding the safety of the local private drinking water supply wells due to their proximity to the Graham Road Recycling and Disposal Facility (GRRDF). This health consultation evaluates potential health effects from exposure to nitrates and other contaminants in the residential drinking water supply wells.

Site Background

Community health concerns regarding the potential contamination of groundwater and private wells surrounding the GRRDF were communicated to DOH during a public meeting held on January 28, 1997. DOH did not address these concerns at that time as there was no indication of any threat to private wells from the landfill. In a letter to the West Plains Neighborhood Association dated February 21, 1997, DOH indicated that any relevant data would be evaluated to determine if private wells in the area of the GRRDF were a potential source of chemical exposure. Sampling of private wells in the area of the GRRDF by Ecology in October 1998 provided the needed private well data and it is evaluated here in conjunction with quarterly sampling data from GRRDF monitoring wells and leachate.

Environmental Contamination

In October 1998, Ecology sampled ten private supply wells located in the vicinity of the Graham Road Recycling and Disposal Facility (GRRDF). Three of these wells (1, 2 and 3) were analyzed for volatile organic chemicals (VOCs), nitrates, metals, pesticides, and polychlorinated biphenyls (PCB's). The remaining seven wells (4-10) were analyzed only for nitrates. Recently, an eleventh well, (residential well 11) was sampled for VOCs and nitrate and that data is also included here. The relative locations of these wells and the GRRDF are shown in Appendix A.

The maximum detected levels of the contaminants, respective health comparison values, and well identification numbers are shown in Table 1. Metals, pesticides, and PCBs were either present at background levels or were not detected in the sampled wells. Only contaminants detected in drinking water wells at levels equal to or exceeding a cancer and/or non-cancer screening value were further evaluated as contaminants of concern. Contaminants of concern do not necessarily represent a public health hazard, but do warrant further investigation. Contaminants present at levels below health screening values are unlikely to have a negative health impact.

Table 1. Maximum concentrations of contaminants in residential drinking water wells in the West Plains Neighborhood

Contaminant	Concentration (ppm)	Comparison Value (ppm)	Source of Comparison Value	Well Number
Carbon tetrachloride	0.006	0.0003	CREG	11
Chloroform	0.0006	0.006	CREG	3
Nitrate	29.3	10	MCL	6
Trichloroethylene	0.013	0.003	CREG	11

ppm = parts per million

MCL = Maximum Contaminant Level

CREG = ATSDR's Cancer Risk Evaluation Guide

Contaminants of Concern are shown in **Bold** type

Carbon tetrachloride was detected only at Wells 3 and 11. The level of carbon tetrachloride in Well 3, 0.00045 parts per million (ppm), was less than the level in Well 11, but it still exceeded the Cancer Risk Evaluation Guide (CREG). Trichloroethylene (TCE) was also detected in Wells 3 and 11, but the CREG was only exceeded at Well 11. Nitrate was detected above the maximum contaminant level (MCL) of 10 ppm in Wells 5 (12.4 ppm) and 6 (29.3 ppm). Nitrate levels greater than one half the MCL were detected in five other wells. Nitrate results and well depth information for all wells are given in Table 1 of Appendix C. As chloroform was detected below the CREG at Wells 3 and 11, it was not considered to be a contaminant of concern at this site.

Well Locations and Potential Sources of Contamination

The locations of the sampled private supply wells and GRRDF are shown on a site map in Appendix A. The flow of groundwater in the vicinity of the GRRDF is complex as there is an alluvial zone, a shallow water aquifer, a mid-depth aquifer (100-120 ft), at least one other deeper aquifer (below 300 ft) , and a gradient control system. As the GRRDF is at a higher elevation than the residential wells, the general flow of groundwater is radial. From the current active area of the landfill, the flow of water in the shallow and mid-depth aquifers is to the south and southwest. From the planned expansion area, the flow of these aquifers is towards the north and northeast. The flow of water from the deeper aquifer (the Grande Ronde) at the GRRDF has not been determined.

Lab analysis of the most recent sampling of leachate from the landfill, in July 1998, detected tetrachlorethylene (PCE) at 6 parts per billion (ppb), 1,1 dichloroethane at 6 ppb, and cis-1,2 dichloroethene at 3 ppb.¹ VOC's have not been detected in the residential wells located downgradient from the cell where leachate was monitored. The flow from this cell is not in the direction of residential wells 3 and 11, the wells that contained VOCs. Thus the residential well VOC contamination is probably not coming from the active area of the landfill. In addition to leachate analysis, several monitoring wells (MW) located around the perimeter of the landfill are periodically sampled and analyzed for VOCs. A single sample taken from MW-1 in April 1995 found PCE and

1,1,1-trichloroethane at 6.5 and 13.9 ppb, respectively. PCE and 1,1,1-trichloroethane were repeatedly found in MW-1A at maximum levels of 6 ppb and 10 ppb, respectively. TCE has not been detected above 5 ppm at any landfill monitoring wells. Recent quarterly sampling of MW-1A from May 1998 through January 1999 has not detected VOCs. There is no VOC monitoring data for the areas of the GRRDF (specifically the expansion area) which have groundwater flow towards the contaminated wells. Since it is unclear as to where the carbon tetrachloride and TCE contamination in residential Well 11 is coming from, monitoring upgradient of the residential well is suggested. The expansion area of the GRRDF should be included in this sampling.

Historically, the levels of nitrate at the GRRDF and surrounding area have been high.² This may reflect local land use practices which may be a source of the nitrate. Common sources of nitrates in drinking water include: agricultural land use, fertilizers, barnyards, feedlots, animal manure piles, and septic systems.³ Residential Well 6, which has the high nitrate levels is located in the deep aquifer (see appendix C for well depth information). It is unusual to see high nitrate contamination in wells located in deep aquifers such as this residential well. However, it is possible that nitrates from the surface might move down a poorly constructed well. Other residential wells located in the deep aquifer (wells 7 and 8), and a deep irrigation well at the GRRDF (located near residential well 6) do not show such high nitrate levels. Nitrates have not been detected at significant levels in leachate at the GRRDF, and the concentrations in groundwater at the site are at least 10-fold greater than the leachate levels. The nitrate levels in the groundwater, as measured at some of the monitoring wells in the shallow water aquifer at the GRRDF have been increasing over time.¹ The levels of nitrate in MW-6A have increased more than 4-fold since 1995 and the nitrate levels at MW-8A have more than doubled. The residential wells appear to draw water from either the mid-depth or deeper water aquifers (see Appendix C).

Discussion

Nitrate, carbon tetrachloride, and trichloroethylene (TCE) were detected in individual domestic wells at levels exceeding their respective comparison values. These contaminants were further evaluated to determine potential health risks and are discussed below.

Nitrate

Nitrate toxicity is due primarily to its conversion to nitrite and subsequent formation of methemoglobin.⁴ Methemoglobin does not bind oxygen, resulting in the decreased transport of oxygen from the lungs to the tissues, a condition known as methemoglobinemia. Methemoglobinemia can be difficult to diagnose as the symptoms include: lethargy, vomiting, diarrhea, and the development of a bluish skin tone (blue baby syndrome). Severe methemoglobinemia can be fatal. The US Environmental Protection Agency (EPA) has set a maximum contaminant level (MCL) for nitrate in drinking water at 10 ppm.

Infants (0-3 months) are particularly at risk to methemoglobinemia. This is due to their high gastrointestinal pH, which favors the growth of nitrate reducing bacteria, and the fact that, when compared to adult hemoglobin, fetal hemoglobin is more easily oxidized to methemoglobin.

Pregnant women, and persons of all ages with reduced gastric acidity or a hereditary lack of methemoglobin reductase are also at risk for methemoglobinemia.⁴ Nitrate contamination in drinking water wells is often accompanied by bacterial contamination that can increase the conversion of nitrate to nitrite resulting in higher toxicity.

The estimated dose of nitrate for an infant consuming water from residential well 6 is 3-fold higher than EPA's oral reference dose (RfD). The RfD is a level of exposure below which adverse health effects are not expected. This level is based on early clinical signs of methemoglobinemia in infants. ***Infants exposed to the amount of nitrates found in Well 6 might be at risk for methemoglobinemia.***

Reference Dose

EPA establishes a Reference Dose (RfD) to protect against adverse non-cancer health endpoints. The RfD is the level of daily exposure below which there is believed to be no appreciable risk of deleterious effects during a chronic exposure period. RfD's include safety factors which protect against uncertainty in the data.

Some animal and human studies suggest that nitrates may have some reproductive and developmental effects. Results from these studies were either not significant or were limited by internal inconsistencies and the presence of other contaminants in the water.^{5,6} The relationship between nitrates in drinking water and reproductive effects in humans remains to be established. ***As the estimated dose from the current exposure is below effect levels seen in animal studies, increased developmental and reproductive effects would not be expected.***

Carbon Tetrachloride

Carbon tetrachloride is a clear liquid that is most often identified as a colorless gas due to its rapid evaporation from water and soil. At levels nearing 10 ppm, carbon tetrachloride has a detectable sweet smell. Carbon tetrachloride does not occur naturally, but is manufactured for use predominantly as a refrigerant, aerosol propellant, and cleaning fluid. It is usually found in the environment near industrial locations or chemical waste sites where emissions are poorly controlled⁷. Levels of 0.5 ppb in water, and up to 0.1 ppb in air are common, especially in industrial areas.⁷ Carbon tetrachloride releases to water are mostly due to discharges from carbon tetrachloride production facilities.

Carbon Tetrachloride and Cancer Risk

EPA has classified carbon tetrachloride as Group B2 probable human carcinogen because it can cause hepatocarcinomas in rats, mice, and hamsters after ingestion. Cancers have not been detected after exposure by inhalation or skin

Cancer Risks

Cancer risk estimates never reach zero, regardless of how minimal the exposure to a carcinogen may be. Terms used to describe this risk are defined below as the number of excess cancers that may be expected in a lifetime.

<u>Term</u>		<u># of Excess Cancers</u>
Low	is approximately equal to	1 in 10,000
Very low	is approximately equal to	1 in 100,000
Slight	is approximately equal to	1 in 1,000,000
Insignificant	is less than	1 in 1,000,000

contact. ***A very low increase in cancer risk is estimated for chronic exposure to levels of carbon tetrachloride found in Well 11.*** A lifetime exposure at this level is estimated to result in 2.7 additional cancers per 100,000 persons exposed from childhood through adulthood. The presence of chloroform and trichloroethylene (TCE) in Wells 3 and 11 does not significantly add to the cancer risk calculated for carbon tetrachloride. Exposure assumptions are given in Appendix B.

Carbon Tetrachloride and Non-cancer Risk

Non-cancer adverse health effects are not expected to result from exposure to carbon tetrachloride detected in private supply wells. The estimated dose calculated for the most sensitive population exposed to the levels of carbon tetrachloride found in Well 11 are just below the RfD.

Noncancerous effects of carbon tetrachloride include cellular necrosis, liver, kidney and nervous system damage. Most of these adverse health effects have been identified after high-dose, short-term exposures through oral, inhalation and dermal pathways. The effects on the liver, kidney and nervous system (dizziness, headache, and nausea) often disappear after the exposure has ended. Populations that are unusually susceptible to the effects of carbon tetrachloride include: moderate to heavy drinkers; persons that have increased risk for kidney or liver damage and persons who take drugs such as phenobarbital or are exposed to certain insecticides.⁷

Trichloroethylene

Trichloroethylene (TCE) is a non-flammable solvent that is often used in industrial settings for metal cleaning. TCE is also found in many adhesives, paint removers, and spot removers. TCE is a colorless liquid that is odorless at low levels (below 100 ppm). In the United States, the average level of TCE in groundwater is 0.007 ppm.¹⁰ Today, the largest releases of TCE occur at chemical waste sites, where exposure to TCE can occur through inhalation, ingestion, and dermal absorption. TCE dissolves easily in water but a portion of the TCE present may quickly evaporate to the air. When TCE is present in household water, exposures can occur not only by drinking the water, but also through dermal contact during daily tasks (dishwashing, cleaning, and bathing), and through inhalation of vapors that come from the water during showering, cooking, and other household tasks.¹⁰

Trichloroethylene and Cancer Risk

Until 1994, TCE was classified by EPA as a probable/possible human carcinogen. This classification has been rescinded and TCEs potential cancerous effects are currently under review. The National Toxicology Program (NTP) is also currently reviewing TCE. The International Agency for Research on Cancer (IARC) has classified TCE as probably carcinogenic to humans. Animal studies have shown that high levels of TCE may cause liver, lung, and testicular tumors. These studies should be viewed cautiously as other potentially carcinogenic compounds were present in addition to the TCE. There is no absolute evidence linking TCE to cancer in humans. Studies in human populations have attempted to characterize the effects of high levels of TCE on exposed

workers. These studies were often limited by a small study size or the presence of multiple chemicals which can make the interpretation of health outcomes very complicated. TCE in drinking water has been linked to leukemias, specifically in children, in studies in New Jersey and Massachusetts.¹⁰ The interpretation of these studies is very controversial as other contaminants were present in the drinking water, the exposure level and duration were not well defined, and the number of participants in the studies was small.

In the West Plains neighborhood, chronic exposure to the levels of TCE found in Well 11 would cause a slight increase in cancer risk. A lifetime exposure at the current detected TCE level is estimated to result in approximately 5 additional cancers per 1,000,000 persons exposed from childhood through adulthood. The exposure assumptions used for this determination are given in Appendix B.

Trichloroethylene and Non-cancer Risk

Exposure to high levels of TCE can cause dizziness, headaches, skin rashes, and irregular heartbeats. The affected organs can include the: liver, kidney, lung, heart, and nervous system. Exposure to very high levels of TCE can cause coma and death; death is not likely to occur from exposure to the low levels of TCE that are seen at hazardous waste sites. Drinking small amounts of TCE for long periods may cause liver and kidney damage, nervous system effects, impaired immune functions, and impaired fetal development in pregnant women.¹⁰ The extent of these effects is unclear as most of the health effects determined to result from TCE exposure have come from animal studies. The data from human studies suggest an association between TCE exposure and developmental effects.¹¹ These effects may include: neural tube defects, heart malformations, oral clefts, low birth weight and increased fetal death. Similar to the studies that examined cancerous effects of TCE, the exposure levels in these studies were not well defined and often there was exposure to multiple contaminants.

ATSDR has set an acute (less than or equal to 14 days exposure) oral Minimal Risk Level (MRL) for TCE at 0.2 mg/kg/day. This is based on developmental effects seen in rats and includes a safety factor of 300 to protect against uncertainty in the data. Exposure to children, through the ingestion, inhalation, and dermal routes, to the drinking water in Well 11 would result in a daily dose that is 125 fold less than the acute MRL. To protect human health, the current exposure is assumed to be chronic and the oral RfD, which represents a safe level for chronic exposure to TCE is a more appropriate value for comparison. This value is currently under review by EPA which is reexamining all the available data to provide updated and accurate health effects information. In animal studies, the lowest amount of TCE that showed an adverse developmental health effect caused fetal heart abnormalities after a 3 month exposure.¹² The level given to the rats in this study was 225 fold higher than the estimated dose that a pregnant woman drinking water from well 11 would receive. It is likely that the risk to pregnant women drinking this water is very low, but until new data is available, it should be assumed that some risk may exist for the children of pregnant women who are exposed to the current TCE levels at this residential well.

Chemical Exposure and Children

Children can be uniquely vulnerable to the hazardous effects of many environmental toxicants. When compared to adults, pound for pound of body weight, children drink more water, eat more food, and breathe more air. Children have a tendency to play closer to the ground and often put their fingers in their mouths. These factors lead to an increased exposure to toxicants in dust and soil. Additionally, before birth, the fetus is highly sensitive to many chemicals that may cause organ malformations and even premature death. For these reasons, it is very important to consider the specific impacts that contaminants may have on children, as well as other sensitive populations.

As discussed above, infants are the most susceptible population to nitrate toxicity. The levels detected in Well 6 represent an increased risk of methemoglobinemia for infants exposed through ingestion of formula prepared with this water. Toddlers and older children are not expected to suffer any adverse health effects from exposure to the levels of nitrate found in any of the private wells sampled.

The liver enzymes that make carbon tetrachloride toxic are less developed in children than they are in adults. Therefore, it is likely that children are less susceptible to the toxic effects of carbon tetrachloride than are adults. Children are not expected to be at an increased risk of adverse health effects from exposure to carbon tetrachloride at the levels reported.

The developing fetus, and children appear to be uniquely sensitive to both the carcinogenic (childhood leukemia) and non-carcinogenic (developmental birth defects) effects of TCE. Based on the analysis discussed in the previous section, the risk to children for developing childhood leukemia from chronic exposure to the levels of TCE detected in residential well 11 are slight. Due to the uncertainty in the current data, it should be assumed that a risk may exist for pregnant women who are using residential well 11. Because the highest risk of developmental effects occurs within the first 3 months of pregnancy, it is possible that even short-term exposure (3 months) to the TCE in well 11 could lead to an adverse health outcome.

Conclusions

A potential public health hazard exists for infants (0-3 months) whose formula is prepared with water from Well 6. A potential public health hazard also exists for pregnant women and others who are at high risk for the effects of methemoglobinemia. If this well is also contaminated with bacteria, these risks may be even greater. The users of Well 6 have been informed of the high nitrate levels and the Spokane County Regional Health District has recommended that they use bottled water. A public health hazard exists if the populations at risk are not utilizing bottled water. A potential public health hazard also exists for users of those wells with lesser nitrate contamination that still exceeds the MCL. The pathway of exposure to nitrates is only through the drinking water route as nitrates are not volatile and will not be found in air.

A very low public health hazard exists from exposure to the levels of carbon tetrachloride found

in Well 11. At the levels present, the increased risk of cancer, due to chronic exposure, is very low. Non-cancer risks are not expected to result from the current exposure levels. Analysis of these exposure risks included ingestion through drinking water and inhalation to account for the volatilization of carbon tetrachloride into the air from the water source. Providing bottled water to residents using Well 11 will cut the risk in half, but there will still be exposure through the volatilization of carbon tetrachloride into the air from the water used for daily tasks which may includes bathing, dishwashing, and cooking.

At the present levels, the increased risk of cancer, due to chronic exposure to the TCE in Well 11 is very low. ***A public health hazard does exist for pregnant women who are exposed to TCE at the levels measured in residential Well 11.*** This is due to the developmental effects of TCE. Providing bottled water to residents using Well 11 will cut the risk in half, but there will still be exposure through the inhalation of the vapors and absorption through the skin during normal water usage which includes bathing, dishwashing, and cooking.

Recommendations

- Drinking water supply wells that exceed the maximum contaminant level (MCL) for nitrate should not be used for drinking purposes. This is especially critical for infants (less than one year of age), pregnant women, persons with reduced gastric acidity, and persons of all ages with a hereditary lack of methemoglobin reductase.
 - ê **Actions:** Ecology has already recommended that the family that uses Well 6 switch to bottled water. The Spokane Regional Health District has spoken to this family and educated them as to the risks that they incur by not switching to bottled water. DOH will provide appropriate information and recommendations to the residents using other wells that exceed the MCL for nitrate.
- Drinking water wells that contain greater than 5 ppm nitrate should be monitored quarterly. This will help to better characterize the contamination and assist in identifying other contaminants, such as microbes, that might enhance the negative health effects of the nitrates.
 - ê **Actions:** DOH will provide appropriate information and recommendations to the residents using wells that contain nitrate greater than 5 ppm. This will be done with the assistance of the Spokane Regional Health District.
- An alternative water supply should be used by the residents who are currently using residential Well 11. This should be continued until the maximum contaminant level (MCL) for carbon tetrachloride and TCE in drinking water are no longer exceeded. Further sampling should be conducted at this well, and also at Well 3 to monitor the VOC levels.
 - ê **Actions:** The Spokane Regional Health District has spoken with the users of well 11 and recommended that they switch to bottled water and consider an alternative water source. DOH will distribute a fact sheet to the local well users to summarize the results of this health consultation. If necessary, further health education material will be provided.

- Quarterly sampling should be conducted at residential Wells 11 and 3 to monitor the VOC levels. This should be continued until an alternative water source is made available or the carbon tetrachloride and TCE level drops below the MCL.

êActions: DOH will consult with the Spokane Regional Health District and DOE to confirm that appropriate monitoring is conducted.

- The source of TCE contamination at residential Well 11 should be determined. Historical land use practices should be examined and potential source(s) in the vicinity, including the Fairchild Air Force Base and the GRRDF expansion area should also be considered. Determination of the source(s) should include monitoring in the vicinity if necessary.

êActions: The Spokane Regional Health District and DOE will be asked to look at the historical land use and potential sources of the carbon tetrachloride and TCE contamination. Monitoring of specific sites will be left to their discretion.

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Appendices

A. Site Map

see attached site map

Map not drawn to scale.

B. Exposure Assumptions

In the analysis conducted in this consultation, children and adults were assumed to be exposed to volatile VOC's through ingestion and non-ingestion routes. Non-ingestion exposures are assumed to occur during daily activities including cooking, bathing, and dishwashing. It was assumed that noningestion routes of exposure (dermal and inhalation) for carbon tetrachloride and TCE were equal to exposures through ingestion. Exposure analysis was conducted using the formulas shown below.

$$\text{Exposure Dose} = (\text{Cw} \times \text{IR} \times \text{EF} \times \text{ED}) / \text{BW} \times \text{AT}$$

$$\text{Excess Cancer Risk} = \text{Exposure Dose} \times \text{CSF}$$

Cw = concentration of contaminant in water (ppm)

IR = Ingestion Rate

For adults an ingestion rate of 2L water/day is assumed. For pregnant women the ingestion rate was assumed to be 2.2L water/day. Children were assumed to consume 1L of water/day until 5 years of age, then 2L water/day for the remaining years. Infants were assumed to consume 0.64L formula/day.

EF = Exposure Frequency (days/year)

It is assumed that people were exposed for 350 days/year

ED = Exposure Duration (years)

It was assumed that residents were exposed to contamination for 30 years. 30 years represents the average time that a person spends at one residence. This is a complete exposure pathways and accounts for all potential past, future and current exposures.

BW = Body Weight (kg)

For adults a 70 kg body weight is assumed. For children, 5 years at 16 kg, 10 years at 40 kg and 15 years at 70 kg body weight is assumed. An infant is assumed to weigh 4 kg.

AT = Averaging Time (days)

For exposure to carcinogens this is assumed to be 70 years x 365 days/year. For noncarcinogens, this is the actual length of the exposure period.

Exposure Dose = is determined as shown above and expressed as mg/kg/day.

CSF = Cancer Slope Factor

This value is derived by EPA and represents the plausible upper-bound lifetime probability of an individual developing cancer from an exposure.

C. Environmental Data

Table 1. Nitrate levels in all the monitored off-site drinking water wells in the West Plains Neighborhood

Well Number	Well Depth (ft)	Nitrate Concentration (ppm)	MCL (ppm)
1	175	1.72	10
2	150	4.22	10
3	110	7.25	10
4	180	5.43	10
5	180	12.4	10
6	340	29.3	10
7	384	7.98	10
8	342	9.14	10
9	128	3.43	10
10	110	9.94	10
11	90-100	9	10

ppm= parts per million

MCL = Maximum Contaminant Level

Bold type represent wells that exceed the MCL